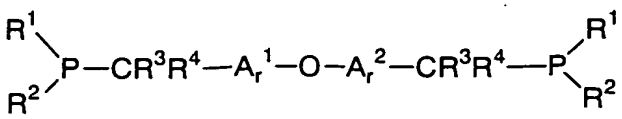
Claims

1. A bisphosphine having a crosslinking group and represented by the general formula (I)



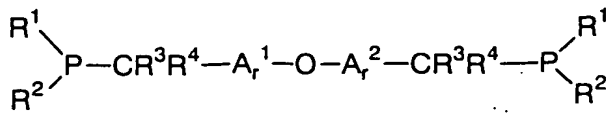
(I)

wherein Ar^1 and Ar^2 each represents an arylene group which may be substituted; R^1 and R^2 each represents an alkyl group which may be substituted or an aryl group which may be substituted, or R^1 and R^2 may combinedly form a ring together with the phosphorus atom bonded thereto; R^3 and R^4 each represents hydrogen atom or an alkyl group; and the carbon atoms each having R^3 and R^4 are bonded in positions ortho to the oxygen atom bonded to Ar^1 and Ar^2.

2. The bisphosphine according to Claim 1, wherein in the general formula (I) the arylene group represented by each of Ar^1 and Ar^2 is phenylene, the aryl group that may be represented by each of R^1 and R^2 is phenyl, and R^3 and R^4 each represents hydrogen atom.

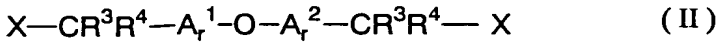
3. The bisphosphine according to Claim 1, being 2,2'-(bisdiphenylphosphinomethyl)diphenyl ether, 2,2'-(bisdiphenylphosphinomethyl)-6-methoxy-diphenyl ether, or 2,2'-bis(diphenylphosphinomethyl)-4-t-butyl-diphenyl ether.

4. A process for producing bisphosphines having a crosslinking group and represented by the general formula (I)



(I)

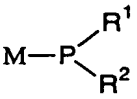
wherein Ar^1 and Ar^2 each represents an arylene group which may be substituted; R^1 and R^2 each represents an alkyl group which may be substituted or an aryl group which may be substituted, or R^1 and R^2 may combinedly form a ring together with the phosphorus atom bonded thereto; R^3 and R^4 each represents hydrogen atom or an alkyl group; and the carbon atoms each having R^3 and R^4 are bonded in positions ortho to the oxygen atom bonded to Ar^1 and Ar^2, which comprises subjecting a compound represented by the general formula (II)



(II)

wherein Ar^1, Ar^2, R^3 and R^4 are as defined above, and X represents an arylsulfonyloxy group, alkylsulfonyloxy group or a halogen atom;

to phosphorylation with an alkali metal phosphide represented by the general formula (III)



(III)

wherein R^1 and R^2 are as defined above, M represents lithium atom, sodium atom or potassium atom.

5. The process according to Claim 4, wherein in the general formula (I) the arylene group represented by each of Ar^1 and Ar^2 is phenylene, the aryl group that may be represented by each of R^1 and R^2 is phenyl, and R^3 and R^4 each represents hydrogen atom.

6. The process according to Claim 4, wherein said phosphorization is carried out in the presence of an ether-based solvent.

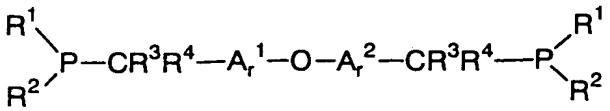
7. The process according to Claim 6, wherein said ether-based solvent is selected from the group consisting of 1,4-dioxane, dibutyl ether, 2-ethoxyethyl ether, diethyleneglycol dimethyl ether, tetrahydrofuran and diethyl ether.

8. The process according to Claim 6, wherein said solvent comprises a mixed solvent comprising tetrahydrofuran and dibutyl ether.

9. The process according to Claim 4, wherein said alkali metal phosphide is used in an amount ranging from 2 to 4 moles per mole of said compound represented by the general formula (II).

10. The process according to Claim 9, wherein said alkali metal phosphide is used in an amount ranging from 2 to 2.2 moles per mole of said compound represented by the general formula (II).

11. A Group VIII metal complex comprising a bisphosphine having a crosslinking group and represented by the general formula (I)



(I)

wherein Ar^1 and Ar^2 each represents an arylene group which may be substituted; R^1 and R^2 each represents an alkyl group which may be substituted or an aryl group which

may be substituted, or R^1 and R^2 may combinedly form a ring together with the phosphorus atom bonded thereto; R^3 and R^4 each represents hydrogen atom or an alkyl group; and the carbon atoms each having R^3 and R^4 are bonded in positions ortho to the oxygen atom bonded to Ar^1 and Ar^2, and a Group VIII metal compound.

12. The Group VIII metal complex according to Claim 11, wherein in the formula the arylene group represented by each of Ar^1 and Ar^2 is phenylene, the aryl group that may be represented by each of R^1 and R^2 is phenyl, and R^3 and R^4 each represents hydrogen atom.

13. The Group VIII metal complex according to Claim 11, wherein said Group VIII metal compound is a rhodium compound, cobalt compound, ruthenium compound or iron compound having catalytic activity for hydroformylation.

14. The Group VIII metal complex according to Claim 13, wherein said Group VIII metal compound is a rhodium compound selected from the group consisting of RhO, RhO_2, Rh_2O, Rh_2O_3, rhodium nitrate, rhodium sulfate, rhodium chloride, rhodium iodide, rhodium acetate, $Rh(acac)(CO)_2$, $RhCl(CO)(PPh_3)_2$, $RhCl(CO)(AsPh_3)_2$, $RhCl(PPh_3)_3$, $RhBr(CO)(PPh_3)_2$, $RH_4(CO)_{12}$ and $Rh_6(CO)_{16}$.

15. The Group VIII metal complex according to Claim 14, wherein said Group VIII metal compound is $Rh(acac)(CO)_2$.

16. The Group VIII metal complex according to Claim 11, wherein the amount of said bisphosphine used is in a range

of 2 to 10000 moles in terms of phosphorus atom per mole of said Group VIII metal compound in terms of Group VIII metal atom.

17. The Group VIII metal complex according to Claim 16, wherein the amount of said bisphosphine used is in a range of 2 to 1000 moles in terms of phosphorus atom per mole of said Group VIII metal compound in terms of Group VIII metal atom.

18. A process for producing aldehydes, which comprises, on hydroformylation of ethylenically unsaturated compounds with carbon monoxide and hydrogen in the presence of a catalyst to produce the corresponding aldehydes, using as said catalyst the Group VIII metal complex according to Claim 11.

19. The process according to Claim 18, wherein a mixed gas comprising carbon monoxide and hydrogen having a H_2/CO molar ratio as feed gas composition of 0.1 to 10 is used.

20. The process according to Claim 19, wherein a mixed gas comprising carbon monoxide and hydrogen has a H_2/CO molar ratio of 0.5 to 2.

21. The process according to Claim 18, wherein the reaction pressure is in a range of 0.1 to 10 Mpa.

22. The process according to Claim 21, wherein the reaction pressure is in a range of 0.2 to 5 Mpa.

23. The process according to Claim 18, wherein the reaction temperature is in a range of 40 to 150℃.

24. The process according to Claim 23, wherein the reaction temperature is in a range of 60 to 130℃.

25. The process according to Claim 18, wherein the amount of said Group VIII metal complex is in a range of 0.0001 to 1000 milligram-atom in terms of the Group VIII metal atom per liter of the reaction liquid.

26. The process according to Claim 25, wherein the amount of said Group VIII metal complex is in a range of 0.005 to 10 milligram-atom in terms of the Group VIII metal atom per liter of the reaction liquid.